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Northeast Corridor Regional Modeling Project Description of the 1980 Urban Field Studies

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16. ABSTRACT

This report describes the design and operation of the 1980 Urban Field Studies conducted as part of the Northeast Corridor Regional Modeling Project (NECRMP). The NECRMP is a multiphase program involving EPA and State/local agencies in the development of the Regional Oxidant Model and its application to the Northeastern United States. The 1980 Urban Field Studies were conducted to provide the data base of air quality and meteorological measurements necessary for modeling the major Corridor cities: Washington, Baltimore, New York and Boston. [A data base for modeling Philadelphia was acquired in 1979.] The 1980 field studies included continuous surface measurements of ozone, nitrogen oxides, hydrocarbons, wind speed, wind direction, temperature, and solar radiation in the vicinity of these cities. In addition, special measurements of hydrocarbon species, aircraft monitoring flights, sodars, pilot balloon observations, and rawinsonde soundings were employed to obtain air quality and meteorological measurements aloft in the Corridor. Quality assurance procedures conducted as part of the data collection/reduction tasks are also described in the report. Lists of the designated NECRMP monitoring sites and the dates/times of species sample collection and of measurements aloft are provided in the appendices.

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Northeast Corridor Regional Modeling Project Description of the 1980 Urban Field Studies

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Research Triangle Park, North Carolina 27711

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Northeast Corridor Regional Modeling Project
Description of the 1980 Urban Field Studies

1.0 Background

The Northeast Corridor Regional Modeling Project (NECRMP) is being conducted to support the development of effective and equitable control strategies necessary to reduce ozone concentrations in the Northeast. It has been recognized that high ozone concentrations are pervasive throughout the Northeast and that significant interurban pollutant transport can occur between Corridor cities. In this regard, the project was designed as a joint venture between EPA, State/local agencies, and Metropolitan Planning Organizations in the Northeast to take an uniform approach to the control of ozone within this Region. The focus of this approach is the development of various control strategies through combined application of Regional and urban scale photochemical models. The Regional Oxidant Model[1] to be used in NECRMP is being developed by the EPA Environmental Sciences Research Laboratory (ESRL). The Airshed[2] and/or the OZIPP/EKMA Model[3] will be applied as the urban model for the large Corridor cities. The structure of the NECRMP and the models selected for strategy development have been described, in detail, elsewhere.[4,5]

The development, evaluation and application of the selected models requires a rather extensive data base to describe the air quality, meteorology and pertinent emissions within the NECRMP modeling domain. The NECRMP Regional domain (large grids) and urban domain (small grids) are shown in Figure 1. Several large field monitoring programs were conducted during 1980 to gather the data base required for modeling this region. One portion of the NECRMP monitoring effort, the Northeast Regional Oxidant Study (NEROS), was conducted to principally support the development and application of the Regional model. As part of the NEROS, various large scale monitoring experiments were conducted across the Regional domain, together with urban plume experiments in Columbus, OH and Baltimore, MD. The specific field programs which comprise the NEROS are described in reports by Clarke, et al.,[6] Vaughan, et al.,[7] and Possiel, et al.[4] The focus of this report is the NECRMP Urban Field Studies conducted to obtain the ambient data base necessary for application of the urban model(s) to the major Corridor cities. The report describes, in detail, the design and procedures of these studies.

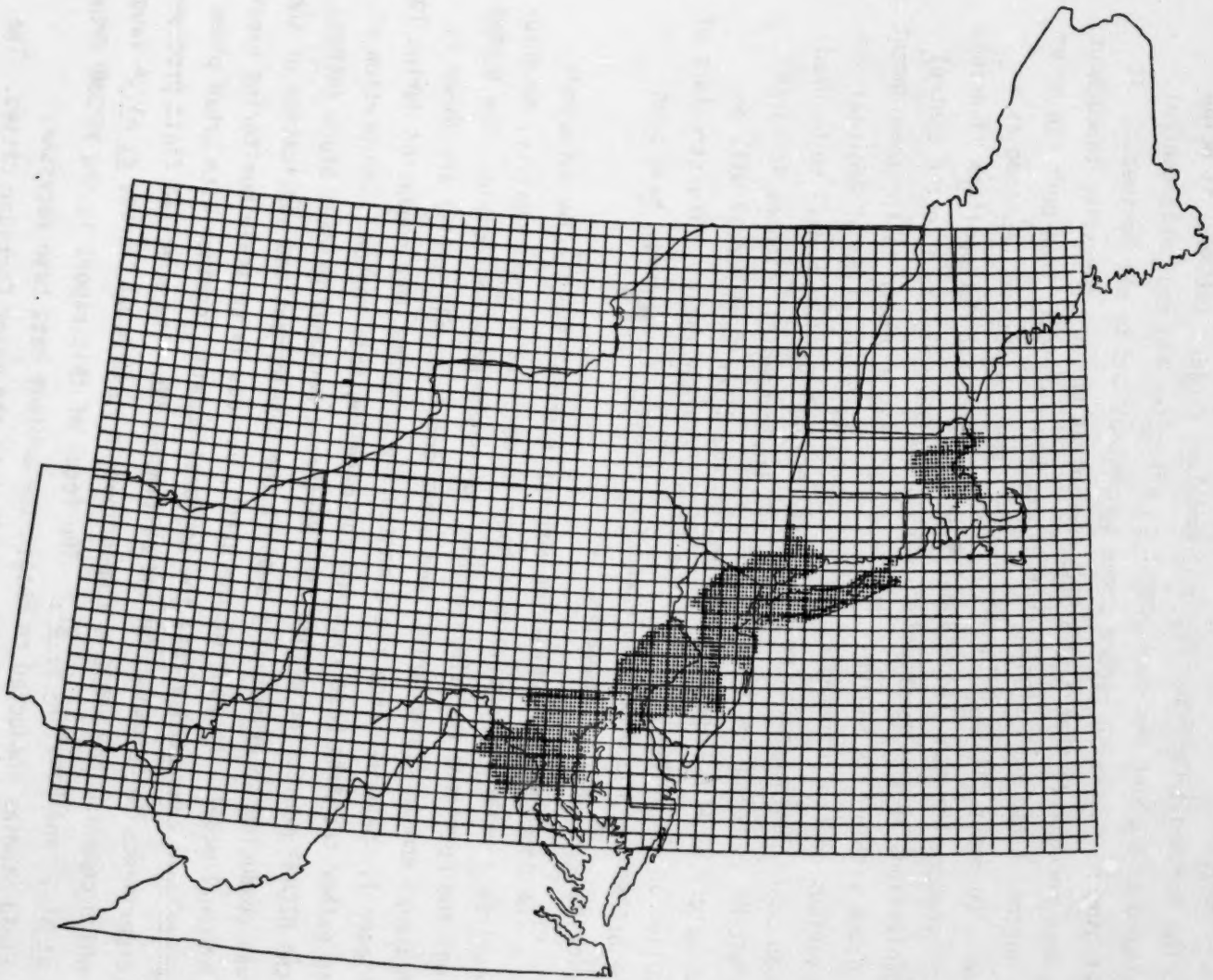

Figure 1. NECRMP regional/urban modeling domain.

2.0 Introduction

The urban studies were conducted from June through mid-September 1980 to gather the ambient data base necessary for application of the Airshed model to Washington, DC, Baltimore, New York, and Boston. [Philadelphia, which is also included in the modeling program, was subject to an intensive data collection effort in 1979.] The data base, although collected to run Airshed, is more than sufficient for applying less complex models, such as OZIPP/EKMA.

In general, the ambient data requirements for applying Airshed include specifying pollutant concentrations at the boundary of the modeling domain, and initial concentrations in each grid cell. Also, meteorological measurements are needed to define the horizontal and vertical flux of the pollutant species. Verification of the model against ambient data requires specification of pollutant concentration fields for each predictive time step. These broad data requirements led to the development of a four-part monitoring program designed to collect the required data base. The four monitoring tasks included continuous surface air quality and meteorological measurements, air quality measurements aloft (via aircraft), upper air meteorological measurements, and hydrocarbon species measurements. The following sections describe each of the monitoring tasks and the associated quality assurance program.

3.0 Surface Air Quality and Meteorological Measurements

The urban air quality monitoring networks were designed to obtain measurements of ozone (O_3), nitrogen oxides ($NO/NO_2/NO_x$), nonmethane organic compounds (continuous NMOC, and species) and carbon monoxide (CO) at locations upwind, within and downwind of the urbanized portion of each city. In the strictest sense, this would have required a series of monitoring rings around each city, beginning in the core area and extending outward up to perhaps 100 km in order to ensure that the pollutant concentrations were measured under various wind regimes. However, since the highest ozone concentrations in the Corridor are typically associated with the prevailing summer season wind flow (from south through west), the monitoring networks were oriented along a general southwest to northeast axis. A few measurement sites were also located in crosswind directions to provide for some variation in wind flow from the prevailing sector. To supplement the urban

area monitoring and to provide measurements in more remote portions of the Corridor, four remote, rural sites were established and included in the network.

In designing the network for each urban area, existing State/local sites were used to the extent possible. In some cases, new instruments were added to existing sites, and new sites were established to fill in gaps between existing sites. For each city, O_3, $NO/NO_2/NO_x$ and NMOC monitoring sites were situated to the south and west of the city center at a distance of from 30 to 45 km in order to measure pollutants being transported into the urban area at the ground level upwind boundary of the city. Within the urban core, measurements were made principally for $NO/NO_2/NO_x$ and NMOC in order to specify initial concentrations of ozone precursors.

Measurements of $NO/NO_2/NO_x$ and O_3 were also made in suburban areas on the fringe of each city to assess the spatial distribution of NO_x and to measure peak O_3 concentrations during near stagnation conditions or recirculation wind flows. To the north and east of each city, O_3 was measured at numerous locations to record concentrations downwind within the urban plume, and thus provide verification data for model estimates of peak O_3 concentrations.

Surface meteorological measurements of wind speed and wind direction were made throughout the network to help determine surface pollutant transport and to indicate the occurrence of mesoscale surface wind regimes which affect pollutant concentrations. Temperature and solar radiation (direct plus diffuse) measurements were made at a few locations to determine photochemical rate constants needed by the model. These meteorological measurements, obtained at State/local agency and contractor sites, were collected to supplement data from National Weather Service and auxiliary observation stations within the Corridor.

The sites at which measurements were made for O_3 are shown in Figure 2, NMOC in Figure 3, and $NO/NO_2/NO_x$ in Figure 4. Sites at which wind speed and wind direction were measured are in Figure 5, and temperature and solar radiation in Figure 6. A list of the specific air quality and meteorological measurements at each of the NECRMP monitoring sites is given in Appendix A.

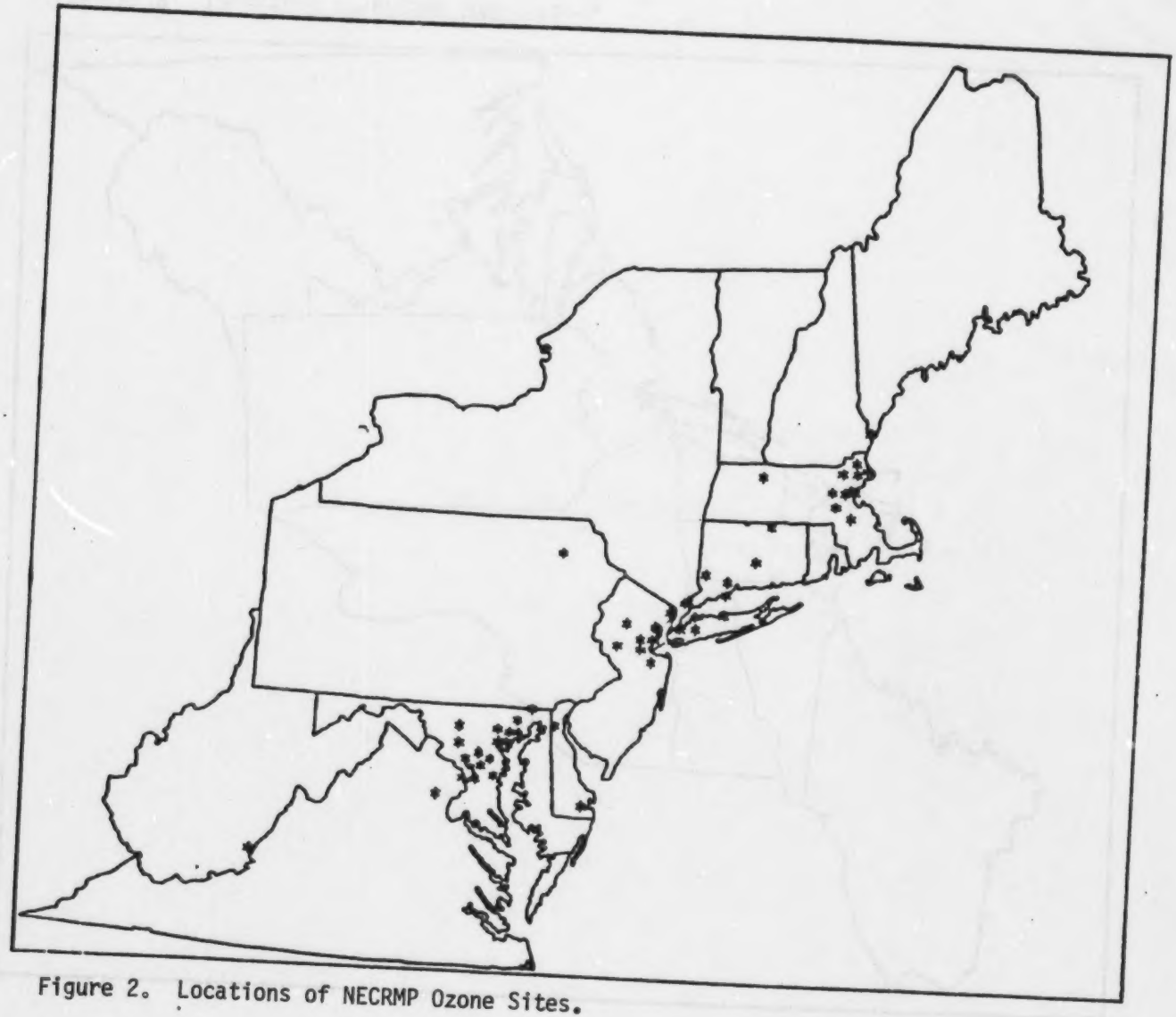

Figure 2. Locations of NECRMP Ozone Sites.

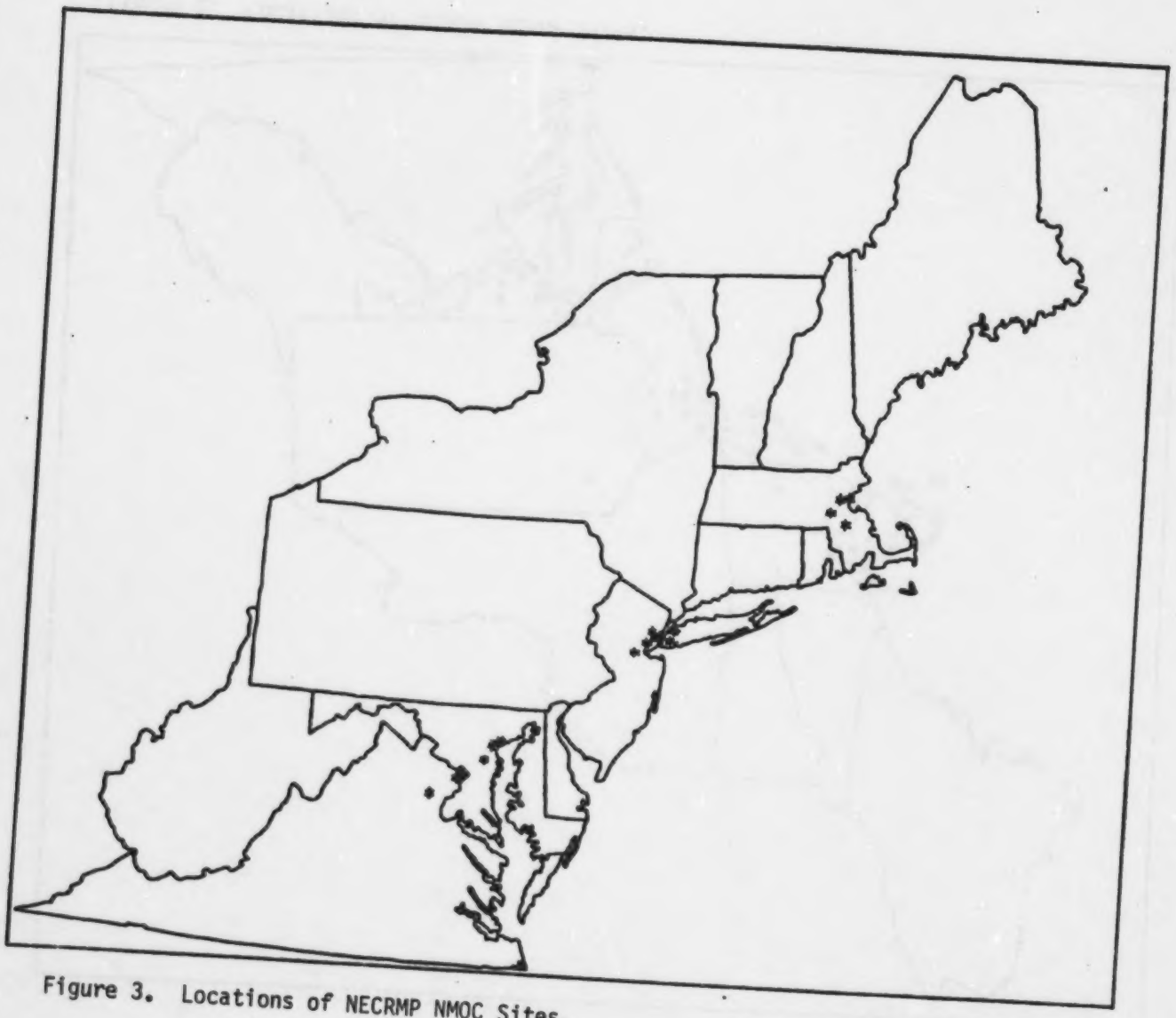

Figure 3. Locations of NECRMP NMOC Sites.

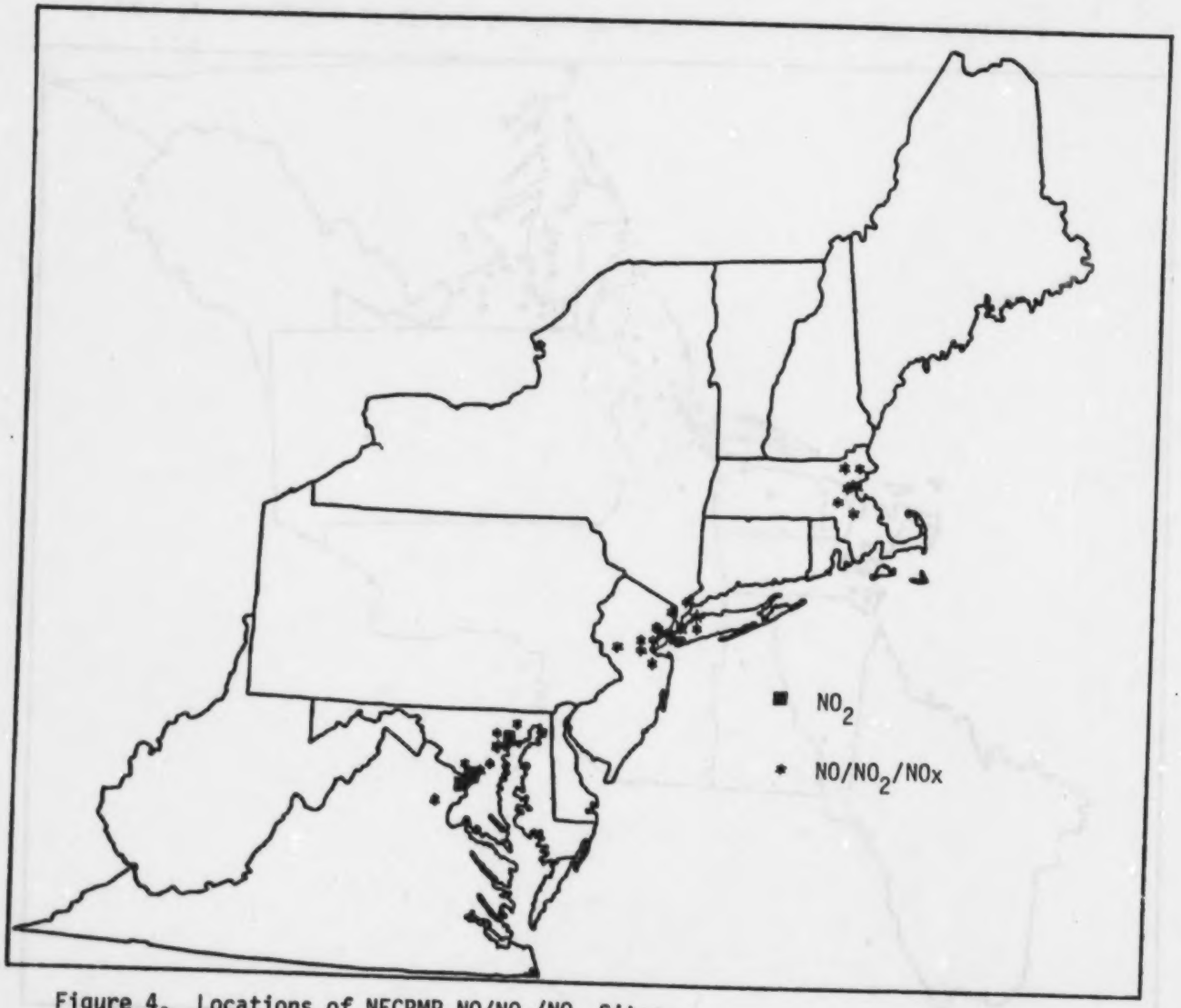

Figure 4. Locations of NECRMP $NO/NO_2/NO_x$ Sites.

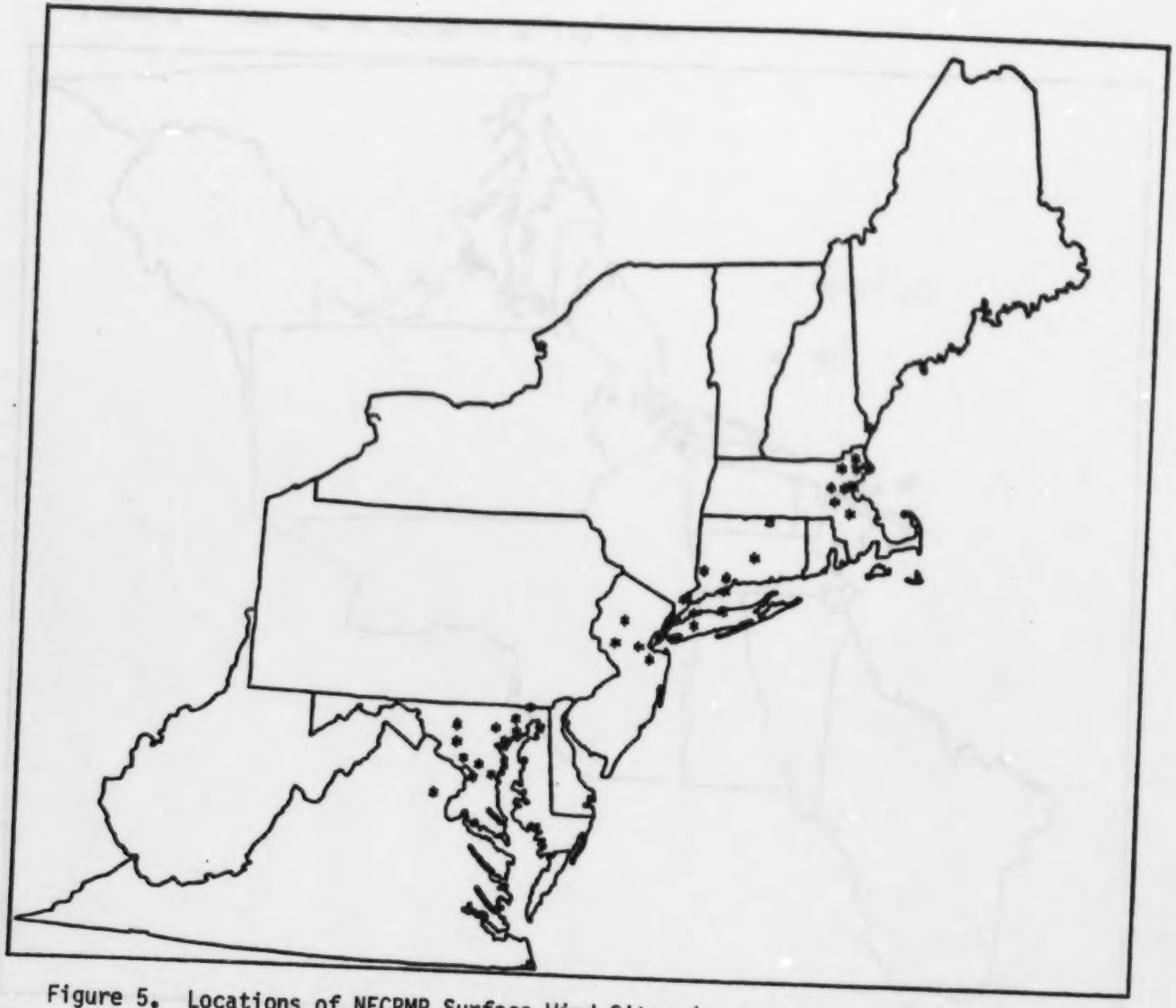

Figure 5. Locations of NECRMP Surface Wind Sites (excluding NWS stations).

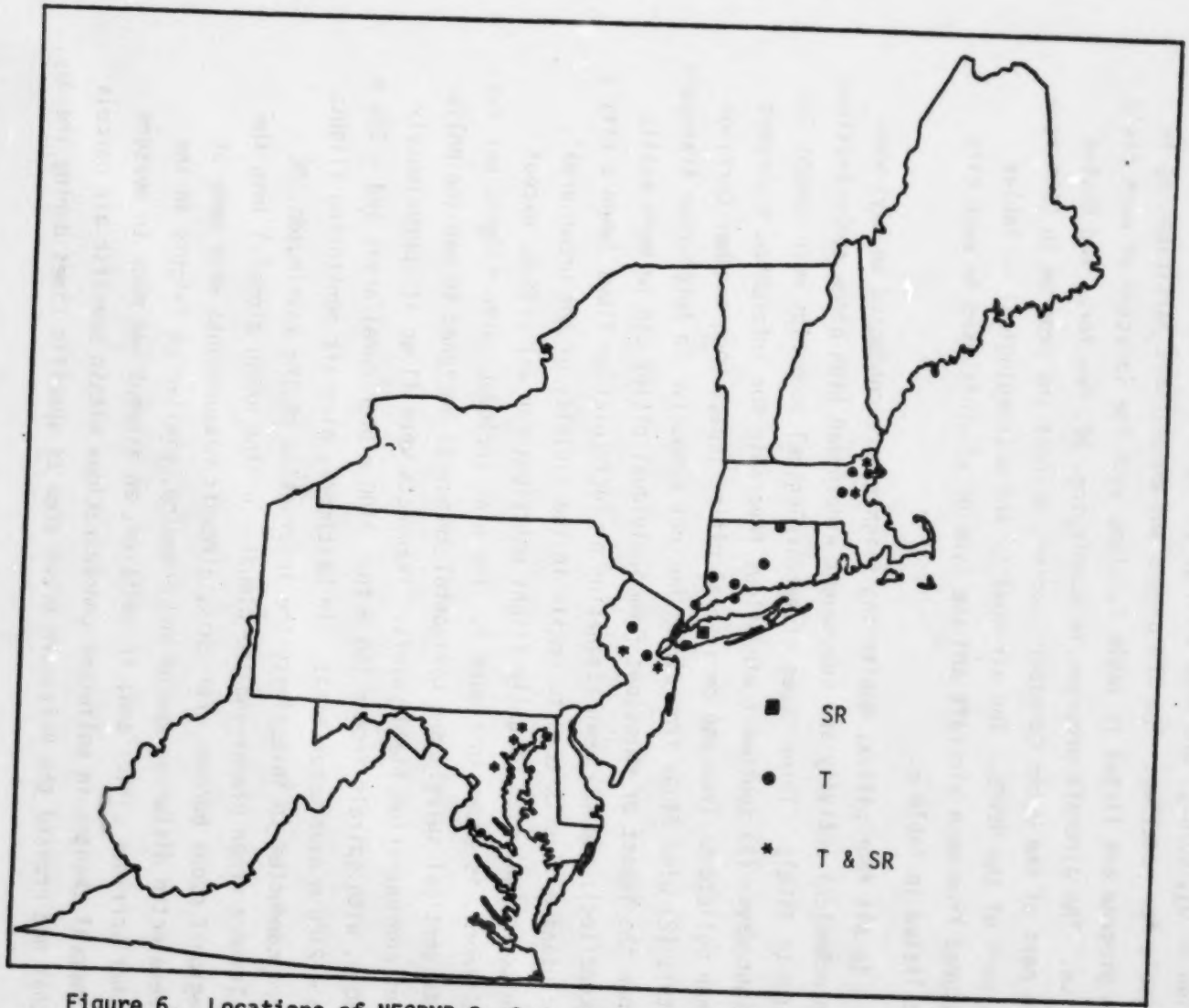

Figure 6. Locations of NECRMP Surface Temperature (T) and Solar Radiation (SR) Sites (excluding NWS stations).

4.0 Aircraft Monitoring

Air quality and meteorological measurements aloft were obtained from instrumented aircraft operated in the vicinity of each of the four cities during a five week period from July 14 through August 15. The intent of the monitoring flights was to describe the horizontal and vertical distribution of O_3, NO/NO_x, and NMOC on high O_3 days which might be potentially suitable for modeling. The EPA groups and contractors participating in this program are listed in Table 1, along with the location of each field office. The aircraft programs in Washington, DC, New York, and Boston were part of the Urban Corridor Studies, whereas the program in Baltimore was part of the NEROS. The air quality and meteorological variables measured from each aircraft and the type of aircraft used in each city are listed in Table 2.

In all four cities, monitoring flights were conducted on days when photochemical activity and subsequent widespread high ozone concentrations would be likely. Three types of meteorological scenarios were sought for flight days: (1) southwest wind flows favorable for interurban transport (when pollutants from one or several cities impact upon another Corridor city); (2) wind flows from directions not conducive to interurban transport (when the impact of emissions from individual cities can be more easily reconciled); and (3) near stagnation or recirculation flows (when a city's pollutant effluents tend to remain in the vicinity of the urban area). The conceptual plan of daily flight emissions for all cities, except Baltimore, is shown in Figure 7. The plan includes three flights per day, with vertical spirals and horizontal transects designed to map the pollutant concentration fields aloft. Transects were flown at approximately 750 m, with spirals from $\sim$ 150 m to $\sim$ 2100 m over rural areas and $\sim$ 300 m to $\sim$ 2100 m over urban areas. In Baltimore, aircraft monitoring flights were conducted to investigate the interaction of the Washington, DC - Baltimore urban plumes and the blending of the urban plume(s) into the regional ozone burden. For this, aircraft measurements were made at preselected distances upwind and downwind, similar to flights in the other Corridor cities and, in addition, an attempt was made to measure temporal changes in pollutant concentrations within specific air parcels that had crossed the Baltimore urban area at specific times during the day.

Table 1. Participants in the Aircraft Measurement Program

Participant	Area of Operations	Field Station
EPA Environmental Monitoring Systems Laboratory - Las Vegas	Washington, DC	Manassas, VA Airport
Brookhaven National Laboratory Washington State University	Baltimore	Middle River, MD Glenn Martin Airport
Battelle Pacific Northwest Laboratories	New York City	Morristown, NJ Airport
Battelle Columbus Laboratories	Boston	Beverly, MA Airport

Table 2. NECRMP Aircraft Measurements

Washington, DC - EMSL/Las Vegas

Aircraft: UH/IH Bell Huey Helicopter

Measurements/Instruments:

Ozone	Bendix 8002
NO/NO_x	Monitor Labs 8440
SO_2	TECO 43
Bscat	MRI 1550B Integrating Nephelometer
Temperature	Rosemont Platinum - Type Total Temperature
Dew-Point Temperature	General Eastern Model 1011 Hygrometer

Baltimore - Brookhaven

Aircraft: Britten Norman Islander

Measurements/Instruments:

Ozone	AID 560
NO/NO_x	TECO 14B
SO_2	Meloy 160-2
Bscat	MRI 1550
Temperature	Yellow Springs 705
Relative Humidity	Weather Measures Model HM 111
Solar Radiation Total	Eppley Pyranometer Model 8-48
Solar Radiation UV	Eppley UV Radiometer Model 14168
Turbulence	MRI Model 1120

Table 2. Continued

Baltimore - Washington State Univ.

Aircraft: Cessna 402

Measurements/Instruments:

Ozone	CSI 2000
NO/NOx	Monitor Labs 8440 HP
Bscat	MRI 1550
Temperature	Metrodata M-8 (bead thermister)
Dew Point Temperature	Metrodata M-8 (carbon strip)
Condensation Nuclei	Environment One-Rich 100

New York - Battelle Pacific Northwest Labs.

Aircraft: Cessna 320 F

Measurements/Instruments:

Ozone	Bendix 8000
NO/NOx	Monitor Labs 8440 HP
Bscat	MRI 1550 Integrating Nephelometer
Temperature	Rosemont Model 102U2U
Dew Point Temperature	EG & G Cambridge Model 137-C

Boston - Battelle Columbus Labs.

Aircraft: Cessna 411

Measurements/Instruments:

Ozone	Bendix 8000
NO/NOx	Monitor Labs 8440 HP
Bscat	MRI 1550 Integrating Nephelometer
Temperature	Rosemont 102U2U
Dew Point Temperature	EG & G Cambridge Model 137-C
Winds	Global VLF System

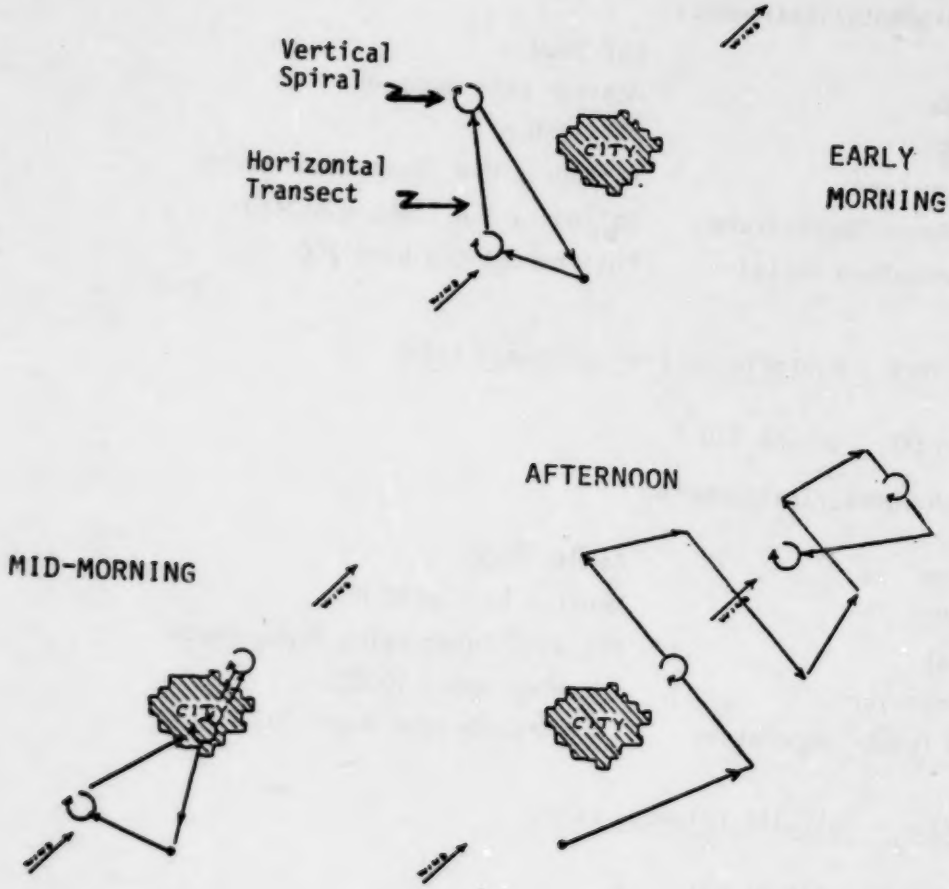

Figure 7. Conceptual Plan for Urban Corridor Monitoring Flights.

The early morning flights in Washington, DC, New York and Boston were used to measure the O_3 and precursor burden aloft prior to the break-up of the surface stable layer in order to define pollutant levels either transported into or remaining over the city from the previous day. These flights were concentrated on the upwind side of the city and included vertical spirals to indicate the presence of vertical gradients in O_3 aloft. Mid-morning flights included spirals on the upwind and downwind fringe and over the urban core to define the vertical distribution of pollutants during the period of rapid change in atmospheric mixing and possible fumigation from elevated plumes. Afternoon flights consisted of cross-wind traverse patterns and spirals downwind of each city to map the dimensions of the urban plume, and thus provide verification data for model predictions in areas between surface sites. Vertical spirals were made over several points downwind, including the area of estimated peak ozone concentration. In Washington, DC and Boston, afternoon flights extended 60-100 km downwind. In New York, measurements were obtained downwind to 100-130 km.

The conceptual flight plan just described was modified, depending upon the configuration of the city, its position in the Corridor, and the meteorological conditions on the flight day. In addition, three major alterations to the plan were: (1) after the first few flight days, the mid-morning flight in New York was discontinued because of flight restrictions and the need to conserve pilot hours for extended afternoon flights; (2) the afternoon flight in Boston included an upwind transect and spiral on days with southwest winds to note any daytime transport from upwind urban areas; and (3) toward the end of the program, the two morning flights in Washington, DC were consolidated in order to conserve flying time.

In order to provide meteorological information to support the flight programs, a temporary weather forecast center was established at Martin State Airport near Baltimore. The center was manned by Brookhaven National Laboratories (BNL) and equipped to receive National Weather Service observations, and forecasts and computer products from the National Meteorological Center in Washington, DC. Forecasts of 12-hour and 18-hour boundary layer winds, cloud cover and precipitation for the study cities were prepared daily and transmitted to the field offices by 1600 EST. The forecasts were used in deciding whether or not to plan a

flight for the following day. Updated forecasts were provided at 0400 EST on flight days. In addition to information received from the forecast center, real-time boundary layer winds were obtained by the field personnel from pilot balloon observations (pibals) made at sites in the vicinity of each city. These measurements were used to fine-tune the direction and distance of flight tracks during the day.

Flight days in New York and Boston were selected independently of each other, since meteorological conditions often differed between the two areas. However, flight days and flight patterns in Washington, DC and Baltimore were closely coordinated in order to maximize use of the aircraft assigned to both cities. At the end of each flight day, flight crews were debriefed by EPA field personnel on the magnitude and distribution of ozone concentrations observed aloft. This information was used in planning subsequent flights.

5.0 Upper Air Meteorological Measurements

A program of upper air meteorological measurements was conducted as part of NECRMP to obtain wind, temperature and mixing height information necessary for the model to estimate pollutant transport and vertical dispersion. Three types of measurement procedures were used: (1) rawinsonde soundings for temperature and wind profiles; (2) pilot balloon observations for wind profiles; and (3) sodars for low level mixing heights (data on the vertical distribution of temperature are also available from aircraft flights). The upper air meteorological measurements began on July 18 and continued through September 12, 1980, except for the pibals which began July 14 and were terminated at the end of the aircraft measurement program. The days with upper air measurements are listed in Appendix B.

Rawinsonde soundings were conducted by Beukers Laboratories at six locations in the Corridor, sodars were operated by AeroVironment at four locations, and pibal observations were taken at six locations by those responsible for the aircraft flights. A list of pertinent information on each measurement site is given in Table 3, and the locations of the sites are shown in Figure 8. These locations were selected in order to characterize both the extent of vertical mixing and mesoscale wind regimes in the vicinity

Table 3 Rawinsonde, Pibal, and Sodar Site Locations

Rawinsonde Soundings

Site Number	Site[1] Type	Site Name	Location	Lat./Long.	Elevation (m MSL)
11	S	Baltimore	Johns Hopkins University	39°19'48"N 76°37'22"W	73
12	U	Boston	Mass. Inst. of Technology	42°21'41"N 71°05'33"W	35
13	S	Derby, CT	Derby High School	41°19'26"N 73°05'26"W	78
14	U	Newark	Rutgers University	40°39'23"N 74°13'18"W	5
15	R	Marlboro, NJ	Municipal Complex	40°19'00"N 74°15'00"W	55
16	U	Washington, DC	National Airport	38°50'36"N 77°02'11"W	3

Pilot Balloon Observations

Site Number	Site[1] Type	Site Name	Location	Lat./Long.	Elevation (m MSL)
1	R	Bel Aire, MD	NECRMP Monitoring site	39°37'37"N 76°19'46"W	10
2	S	Beverly, MA	Municipal Airport	42°35'10"N 70°55'20"W	33
3	S	Glen Cove, NY	Lattington Beach	40°53'30"N 73°35'55"W	24
4	S	Medfield, MA	State Hospital	42°12'44"N 71°20'08"W	84
5	S	Morristown, NJ	Municipal Airport	40°47'50"N 74°25'20"W	57
6	R	Manassas, VA	Municipal Airport	38°43'00"N 77°31'00"W	57

[1] U: urban
S: suburban
R: rural

Table 3. Continued

Sodar Operations

Site Number	Site[1] Type	Site Name	Location	Lat./Long.	Elevation (m MSL)
7	R	Camp Upshur, VA	US Marine Base, Quantico	38°37'25"N 77°37'15"W	61
8	S	Towson, MD	Goucher College	39°24'46"N 76°35'30"W	113
15	R	Marlboro, NJ	Municipal Complex	40°19'00"N 74°15'00"W	55
9	R	Sudbury, MA	Great Meadows National Wildlife Reserve	42°23'05"N 71°23'19"W	37

[1]U: urban
S: suburban
R: rural

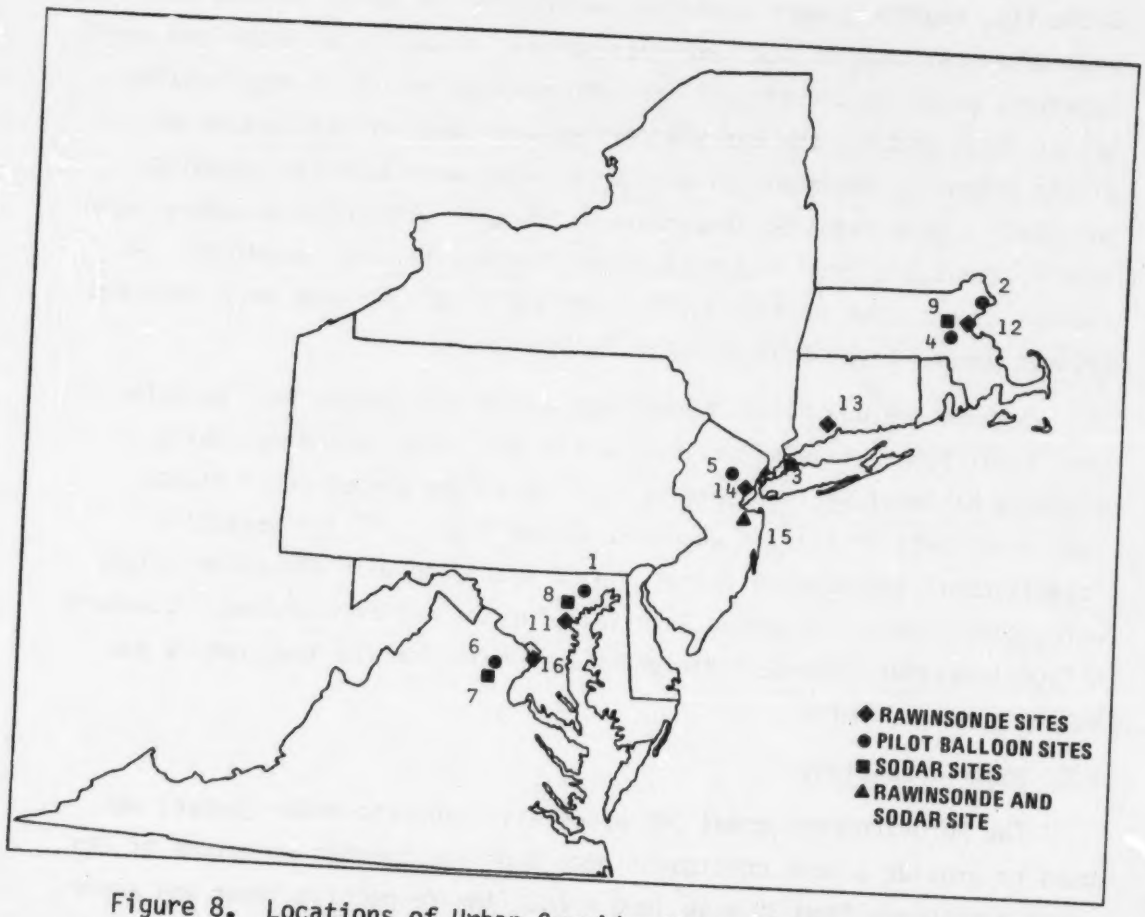

Figure 8. Locations of Urban Corridor Upper Air Meteorological Measurement Sites.

of the Corridor cities. In addition, upper air soundings were obtained at six-hour intervals from National Weather Service stations (except New York City) within the Regional domain, as part of the NEROS.

5.1 Rawinsonde Sounding Operations

The NECRMP rawinsonde soundings were obtained five days per week, typically Monday through Friday, although the schedule was adjusted to obtain soundings on weekend days when aircraft flights were planned. The daily schedule of soundings at each site is provided in Table 4. Basically, soundings were conducted during (1) the early morning to provide an estimate of low level atmospheric stability at urban and rural locations prior to sunrise; (2) the mid-morning period of rapid mixing height rise; and (3) the early afternoon when the vertical extent of mixing reaches a maximum. Slow rise balloons were used for soundings to obtain a more detailed temperature structure within the boundary layer than is available from routine National Weather Service soundings. An average ascent rate of 400 ft./min. was achieved, and data were recorded between ground level and 700 mb ($\sim$ 3500 m) only.

Temperature/dew point temperature and height values for "mandatory" and "significant" levels (pressure altitudes) were determined using standard National Weather Service data reduction procedures,[8] except that a criteria of $\pm$ 1/2°C was used rather than $\pm$ 1°C for selecting "significant" temperature points. Wind speed and wind direction values were determined at 30-second intervals for the entire sounding. Standard National Weather Service radiosondes were used for the temperature and humidity measurements.

5.2 Sodar Operations

The AeroVironment model 300 monostatic acoustic radar (sodar) was used to provide a near continuous record of the thermal structure of the lower atmosphere from 30 m to 1000 m AGL (the respective lower and upper detectable limits of the instrument). Data from the sodar were reduced into 30-minute average mixing height values determined as the height of the base of the lowest stable layer detected by the instrument.

Table 4. Rawinsonde Sounding Schedule

Sounding Site	Start/End Date	Launch Time (EST)
Washington, DC Site 16	July 24 - September 12	0500 0900 1300
Baltimore Site 11	July 16 - September 12	0700 0900 1000a 1200a 1300 1400a 1500a 1600a
Marlboro Site 15	July 17 - August 29	0500 0700 0900 1300
Newark Site 14	July 19 - September 12	0500 0900 1100b 1300c
Derby Site 13	July 16 - September 12	0700 0900 1100 1300 1500
Boston Site 12	July 18 - September 12	0500 0700d 0900 1100d 1300 1500d

a. soundings on July 16 and 31, and August 1, 5, 6, 7 and 14 only.

b. sounding effective September 3.

c. sounding discontinued September 2.

d. winds only, no temperature measurements.

5.3 Pilot Balloon Observations

Pilot balloon observations of wind speed and direction aloft were made almost daily during the period July 14 through August 15, 1980. Thirty-gram balloons were released hourly from 0400 EST through 1700 EST and tracked with a single theodolite. Readings of azimuth and elevation were recorded every 30 seconds for a total of 20 minutes. A constant rise rate was assumed for reducing the raw data into wind speed and direction values. The reduced wind data began at 110 m AGL and continued at approximately 90 m intervals up to 3690 m AGL.

6.0 Hydrocarbon Species Measurement Program

Hydrocarbon species concentrations were obtained at various locations in the vicinity of the study cities in order to define the mix of non-methane hydrocarbons needed as input to the model. Species concentrations were identified by gas chromatographic (GC) analysis of both grab samples and one-hour integrated samples of ambient air. The collection of these samples began on July 14 and continued through August 29.

Integrated ground level samples were collected between the hours of 0500-0600 and 0700-0800 EST at two sites in the urbanized portion of each city. As time permitted, grab samples were collected from a "roving van" at various locations downwind of Washington, DC and Baltimore. The fixed sampling sites are listed in Table 5. Integrated samples were collected in Teflon or Tedlar bags using an automated timer-pump system. The roving van grab samples were collected in stainless steel canisters.

Ambient grab samples were also collected aloft in six-liter stainless steel canisters during aircraft flights. In Washington, DC, New York and Boston, grab samples were obtained within and above the surface stable layer during vertical spirals on early morning flights. In Washington, DC and Boston, two samples were also collected (at different altitudes) over the urban center during the mid-morning flights. In New York, grab samples were collected during the afternoon within the mixed layer over southern Connecticut (these samples were intended to measure the composition of hydrocarbons remaining in the New York plume after the peak in photo-chemical activity). In Baltimore, four grab samples were collected on each flight throughout the day. These samples were used to characterize

Table 5. Fixed Hydrocarbon Species Sampling Locations

Urban Area	Sampling Sites
Washington, DC	West End Library NECRMP site 9
	University of Maryland Campus non NECRMP site
	Takoma Park NECRMP site 10
Baltimore	Read Street NECRMP site 13
	Essex, MD NECRMP site 20
New York City	Newark, NJ New Jersey Inst. of Technology NECRMP site 46
	Linden, NJ NECRMP site 43
Boston	East Boston, MA NECRMP site 27
	Watertown, MA NECRMP site 37

hydrocarbons upwind, within and on either side of the Baltimore urban plume. Not all collected samples were analyzed because of time limitations on the gas chromatographs. However, those samples which were selected for GC analysis were analyzed within 48 hours of collection.

Laboratories for GC analysis were established at Martin Airport near Baltimore and at the New Jersey Institute of Technology at Newark by Washington State University (WSU). In the Boston area, a GC laboratory was operated at Beverly Airport by Battelle Columbus Laboratories (BCL). The specific chromatographs and peripheral data systems are given in references 9 and 10 for WSU and BCL, respectively. A description of the species data are included in reference 11.

7.0 Quality Assurance Program

A comprehensive Quality Assurance (QA) program accompanied the various NECRMP ambient measurement programs. The objectives of the QA program were as follows:

(a) to obtain a data base of measurements as precise and accurate as possible within the limitations of available manpower and funds;

(b) to obtain a high percentage ($\geq$ 90%) recovery of data during the measurement program;

(c) to ensure that surface measurements are representative of the desired spatial and temporal scales; and

(d) to ensure that all air quality measurements are traceable to a single source (National Bureau of Standards [NBS]) in order to provide internal consistency and comparability among measurements made by the various study participants.

Assistance in designing and implementing the QA program was provided by the Environmental Monitoring Systems Laboratory (EMSL) at Research Triangle Park, North Carolina. All of the air quality analyzers (except for those measuring NMOC) were operated using EPA designated reference or equivalent methods. The NMOC analyzers (MSA model 11-2) were selected by EMSL-RTP for use in this study, based upon the results of their evaluation of several state-of-the-art instruments. The specific QA activities are described below for each NECRMP measurement program.

7.1 QA - Surface Monitoring

The QA activities conducted during the surface monitoring program were developed from requirements for National Air Monitoring Stations (NAMS), as specified in 40 CFR Part 58, Federal Register, May 10, 1979.[12] Guidance for implementing the QA plan is contained in Volume II of the "Quality Assurance Handbook for Air Pollution Measurement Systems."[13] The specific QA elements of the NECRMP surface measurement program included:

(a) systems audits of monitoring sites;

(b) verification of calibration procedures;

(c) instrument calibrations and zero/span and precision checks; and

(d) instrument performance audits.

7.1.1 Systems Audits

Systems audits were conducted by Research Triangle Institute (RTI), under contract to EMSL-RTP. As part of this effort, 24 of the designated NECRMP sites were evaluated during the period May 22 through June 11, 1980. These sites were selected to represent monitoring operations by each of the agencies and contractors participating in the surface monitoring portion of the study. The general items checked at each site included the following:

(a) suitability of the location and exposure for O_3 and $NO/NO_2/NO_x$ monitoring;

(b) the sample inlet system leading into the site, including the placement and height of the probe:

(c) the analyzer set up (e.g., gas connections, power connections);

(d) the calibration systems (including zero air and standards); and

(e) the record keeping and documentation of site operations.

Other more specific items checked by RTI are listed in Table 6. Meteorological systems were also checked to ensure that the instrument had an unobstructed exposure and that the systems were operating normally. The results of the systems audits are documented in a report by RTI.[14]

Table 6. Systems Audit Evaluation Items

A. Ambient Air Analyzer Checks

Ozone -

Equivalency designated analyzer

Calibration system (ozone source, dilution source, UV photometer, or transfer standard)

Ethylene purity

Flowmeter range and accuracy; flowmeter calibration

Repair parts available

Proper electrical and pneumatic installation

Oxides of Nitrogen -

Equivalency designated analyzer

Suitable calibration system

NBS-traceable NO in nitrogen cylinder and/or NBS-traceable NO_2 permeation tube

Suitable flowmeters; flowmeter calibration

Proper electrical and pneumatic installation

B. Pollutant Standards Delivery System

Availability and adequacy of dilution and/or gas phase titration equipment

Proper grade and traceability of pollutant standards

Stability of ozone generator; proper plumbing

Calibration and precision checks accomplished by delivering pollutant to analyzer while it is in its normal ambient sampling configuration

C. Site Location

Unobstructed airflow

Sited according to current EPA criteria

Security

Distant from sources of oxides or nitrogen or hydrocarbons

Table 6. (continued)

D. Site Facilities

Cleanliness

Sufficient workspace

Safety

Temperature control

Adequate voltage

Inlet probes, manifolds, blowers; their cleanliness and integrity

E. Site Operation

Calibration procedures, schedule

Zero and span check procedures, schedule

Precision check procedures, schedule

Data transmittal and reduction to concentration units

Audit procedures, schedule

Documentation control charts, operating and reporting procedures

Corrective action procedures

Strip chart annotation, data forms

Routine maintenance procedures, schedule

Recommendations were made by EPA to the site operators for correcting any deficiencies found by the audits. All serious problems were resolved by the agencies as soon as possible.

7.1.2 Interlaboratory Calibration Verification (ICV)

An audit system verification center was established to verify the accuracy of the O3 and $NO/NO_2/NO_x$ audit systems used by audit teams during the summer field program. The center was operated from April 23 through May 1, 1980, by RTI, at the EPA Region II laboratory. Participating in the ICV were representatives from the following agencies:

EPA Region I,
EPA Region II,
Massachusetts Department of Environmental Quality Engineering,
Connecticut Department of Environmental Protection,
New York Department of Environmental Conservation, and
New Jersey Bureau of Air Pollution Control.

The center was equipped with the following analyzers:

Bendix Ozone Analyzer, Model 8002A,
Monitor Labs Ozone Analyzer, Model 8410,
Bendix Total Oxides of Nitrogen Analyzer, Model 8440, and
Bendix Carbon Monoxide Analyzer, Model 3501C5A.

The following approach was taken to maintain a chain of traceability in the NECRMP audit program. Prior to establishing the ICV, RTI's calibration systems were taken to EMSL-RTP for verification against NBS certified standards. RTI then set up and calibrated the above analyzers at the ICV center in Region II. The verification of the participants was accomplished by having each team generate concentrations from their audit systems. These were compared to the predicted concentrations, as calculated from the instrument response and calibration equation established by RTI. The slope (m) and intercept (b) of the linear regression of the two sets of concentrations were used to evaluate the performance of each team for each pollutant. The following criteria were used to judge the performance of the participants:

Excellent Performance Levels

Slope: $0.95 \leq m \leq 1.05$; and

Intercept: -1% FS $\leq b \leq +1\%$ FS (FS = full scale range of analyzer).

Satisfactory Performance Levels

Slope: $0.90 \leq m < 0.95$ or $1.05 > m \leq 1.10$; and

Intercept: -2% FS $\leq b < -1\%$ FS or $1\% > b \leq 2\%$ FS.

Unsatisfactory Performance Levels

Slope: $m < 0.90$ or $m > 1.10$; and

Intercept: $b < -2\%$ FS or $b > +2\%$ FS.

For those systems which gave an unsatisfactory response, the operating procedures and analyzers were checked by RTI and the operator in order to identify the source of the discrepancies. Appropriate corrections/adjustments were subsequently made by the operator. The results of the ICV are documented in a report by RTI.[15]

7.1.3 Instrument Calibrations and Zero/Span and Precision Checks

The O_3 analyzers operated at the surface monitoring sites were calibrated by UV photometry or Gas Phase Titration (GPT), according to requirements in Appendix A of reference 11. The $NO/NO_2/NO_x$ analyzers were calibrated by GPT, according to requirements in Appendix A of this reference. The zero/span and precision checks were conducted for O_3 and $NO/NO_2/NO_x$ analyzers, according to guidelines in reference 13. The specific, routine QA procedures used by Battelle Columbus at their sites in New York and New Jersey, and by Engineering Science in Maryland, are documented in references 16 and 17, respectively. The NMOC analyzers were calibrated by PEDCo, using EPA certified methane and propane calibration gases, according to procedures described in reference 18. The procedures used for zero/span and precision checks for the NMOC analyzers are also described in that report.

The following schedule was prescribed by EMSL for calibrations and for zero/span and precision checks at surface sites:

	Calibrations	Zero/Span Checks	Precision Checks
O_3 and $NO/NO_2/NO_x$	monthly	twice per week	twice per week
NMOC	once every two weeks	daily	three times per week

The above frequency of zero/span checks was recommended to detect drift in instrument response and thereby permit the correction of a problem before data would have to be invalidated. The relatively frequent precision checks were recommended because of the short term nature of the study and the need to provide sufficient data to evaluate statistically the performance of each analyzer during the three month study. This schedule was followed by most of the monitoring agencies and contractors. However, a somewhat less stringent schedule was adopted by a few agencies at particular sites, due to limited personnel and/or calibrators.

7.1.4 Instrument Audits

Audits of the O_3, $NO/NO_2/NO_x$, and NMOC analyzers operated at the designated NECRMP monitoring sites were performed twice during the field program. The agencies participating in the ICV, together with RTI, shared the responsibility for auditing these sites. Instruments found to give an unsatisfactory response to the audit ($\geq$ 15% difference between audit output and instrument response) were recalibrated by the operating agency or contractor. The results of the two audits conducted during the field program are summarized in reference 19.

7.1.5 Reduction of Surface Data

The continuous measurements made at surface monitoring sites were reduced into hourly arithmetic averages, except for wind measurements at sites in New York State which were reduced as vector averages. The precision and audit data collected for each air quality analyzer were used in validating measured values. Each agency/contractor was responsible for judging the precision of its own instruments. However, EMSL-RTP provided an evaluation of precision data for the NMOC analyzers.

The O_3 and NO_2 data were assembled and submitted to the appropriate EPA Regional Office, where they were run through the automated Quality Control (QC) screening tests listed in Table 7.[20] These screening tests

Table 7. Air Quality Control Tests Applied to NECRMP Ozone and Nitrogen Dioxide Data

Tests	Flag Values (ppm) O_3	Flag Values (ppm) NO_2
1. Maximum Value Test: flags unexpectedly high values.	> 0.50 (1000-1700) > 0.38 (1800-0900)	> 0.64
2. Adjacent Value Test: flags an unexpected fluctuation in concentration between two consecutive hours.	± 0.15 (day) ± 0.10 (night)	± 0.27
3. Spike Test: flags the middle value of three consecutive hourly values if it is much higher or lower than the two adjacent hours.	± 0.10 (day) ± 0.05 (night) or ± 300%	± .11 or ± 300%
4. Consecutive Four Hour Test: flags short term clusters of unexpectedly high values.	> 0.25	> 0.53
5. Gap Test: flags unexpectedly high values by checking for gaps in the frequency distribution.	-	-

flagged potentially invalid data points. Agencies and contractors were notified of any flagged values identified at their sites. These data were then verified as valid, or deleted if determined to be invalid. No automated screening tests were run for the NO, NO_x, NMOC, or surface meteorological data; only manual spot checks were made of these data. However, all of the surface air quality and meteorological data will be run through additional screening checks prior to the creation of the modeling data base in 1983.

7.2 QA - Aircraft Monitoring

Quality Assurance activities associated with the aircraft monitoring program included calibrations, zero/span checks and audits of the monitoring systems. The types of monitors operated on board each aircraft are listed in Table 2.

7.2.1 Aircraft Instrument Calibrations

The systems and procedures used to calibrate the air quality instruments operated on board the five aircraft are described in Table 8. For all aircraft systems, the calibration equipment was assayed against NBS-SRM certified equipment prior to the start of the measurement program. Meteorological equipment were also calibrated at that time. The general schedules of calibrations and zero/span checks adopted by each aircraft operator are listed in Table 9. The specific QA procedures followed are in references 21, 22, 23, 24, and 25 for the aircraft in Washington, DC, Baltimore (BNL), Baltimore (WSU), New York and Boston, respectively.

7.2.2 Aircraft Audits

Audits of the air quality instruments were conducted by RTI for each aircraft system during the initial days of the program. Instruments found to give an unsatisfactory response were recalibrated following any necessary instrument repairs or modifications to operating procedures. A summary of the audit results is provided in Table 10. Details of the audits are available in reference 19 for aircraft in Washington, DC, New York and Boston, and in reference 26 for the two aircraft in Baltimore.

Table 8. Procedures and Calibration Systems Used for Aircraft Instruments

Urban Area:	Washington, DC
Aircraft Operator:	EMSL-Las Vegas
Ozone:	Calibrations were performed using a TECO 101 dilution system equipped with an ozone generator, the output of which was monitored with a Dasibi O_3 monitor referenced to a long-path UV photometer.
$NO/NO_2/NO_X$:	Calibrations were performed using a cylinder of NO in nitrogen (N_2) tertiary standard. The span calibration was performed by dilution, using a Bendix Dynamic calibration system with zero air from an Aadco pure air generator. The pure air generator also provided for the zero air calibration.
SO_2:	Calibrations were performed using a cylinder of SO_2 (secondary standard) certified by comparison to an NBS permeation tube. The span calibration was performed using a direct span gas bottle and zeroed using the Aadco pure air generator.
Urban Area:	Baltimore, MD
Aircraft Operator:	Brookhaven National Laboratory
Ozone:	Calibrations were performed using an AID ozone generator, the output of which was verified by Gas Phase Titration with an NBS standard cylinder of NO in N_2.
$NO/NO_2/NO_X$:	Calibrations were performed using a Monitor Labs 8500 calibrator equipped with an NO dilution system and a 46 ppm NBS NO in a N_2 cylinder.
SO_2:	Calibrations were performed using a Monitor Labs 74447 calibrator and NBS traceable SO_2 permeation tube.
Urban Area:	Baltimore, MD
Aircraft Operator:	Washington State University
Ozone:	Calibrations were performed using a MEC 1000 ozone generator, the output of which was verified by UV (Dasibi 1008-PC).
$NO/NO_2/NO_X$:	Calibrations were performed using a Meloy Model CN 020 calibrator with an NBS cylinder of 52 ppm NO in N_2. Span checks were made with a 0.93 ppm NO in N_2 cylinder, the concentration of which was verified by GPT prior to the study.

Table 8. (continued)

Urban Area:	New York City, NY and Boston, MA
Aircraft Operator:	Battelle Northwest and Battelle Columbus
Ozone:	Calibrations were performed using a CSI 1700 Gas Phase Titration calibration system referenced to an NBS certified UV photometer.
$NO/NO_2/NO_x$:	Calibrations were performed using the CSI 1700 with an NBS cylinder of NO in N_2.

Table 9. Frequency of Calibrations and Zero/Span Checks for Aircraft Systems

Washington, DC

- Multipoint calibrations were conducted prior to and following the study.
- Zero/span checks were conducted prior to and following each flight day.
- Zero air calibrations were conducted in flight.

Baltimore (BNL)

- Multipoint calibrations were conducted three times on the $NO/NO_2/NO_x$ analyzer, two times on the O_3 analyzer, and once on the SO_2 analyzer.
- In-flight zero air calibrations for SO_2 were conducted at each flight altitude.
- In-flight zero air calibrations were conducted for O_3 and $NO/NO_2/NO_x$.
- Span checks were performed twice on the O_3 analyzer and once each on the $NO/NO_2/NO_x$ and SO_2 analyzers during the program.

Baltimore (WSU)

- Multipoint calibrations were conducted four times on the O_3 analyzer and once, prior to the study, on the $NO/NO_2/NO_x$ analyzer.
- Zero/span checks were conducted on the $NO/NO_2/NO_x$ analyzer four times during the study.

New York City

- Multipoint calibrations were conducted weekly.
- Zero/span checks were conducted daily between morning and afternoon flights.

Boston

- Multipoint calibrations were conducted weekly.
- Zero/span checks were conducted daily between early morning and mid-morning flights.

Table 10. Audit Summary for Aircraft Instrumentation

	Ratings[1]
Washington, DC	
O_3	S
NO/NO_x	S/E
SO_2	S
B_{scat}	within ± 10%
Baltimore (WSU)	
O_3	S
NO/NO_x	S/E
SO_2	S
B_{scat}	within ± 10%
Baltimore (BNL)	
O_3	S
NO/NO_x	E/E
SO_2	S
B_{scat}	+ 19.4%
New York City	
O_3	E
NO/NO_x	S/S
B_{scat}	within ± 10%
Boston	
O_3	E
NO/NO_x	E/E
B_{scat}	within ± 10%

[1] E = Excellent
S = Satisfactory
U = Unsatisfactory

7.2.3 Instrument Altitude Response

Corrections to measured data for variations in instrument response with altitude were made for O_3 measurements obtained in Boston. For these data, Battelle used relationships described by White.[27] According to these relationships, not adjusting the O_3 data for variations in response due to altitude could result in concentrations too low by 15-25% at 2,000 m, which was about the highest altitude of the aircraft spirals during NECRMP. This is on the order of 0.02 ppm, considering typical values observed at this altitude during the program. In Baltimore, altitude response relationships were developed by BNL and WSU for the particular ozone analyzers operated aboard their aircraft; however, the data have not been adjusted. No altitude corrections were deemed necessary for the other analyzers.

In general, there were no major difficulties with the operation of the on board instrumentation. However, BNL did have some problems maintaining their NO_x analyzer in calibration, due to high cabin temperatures ($\sim$ 35°C) at the ground and aloft. As a result, multi-point calibrations were performed on this instrument on several occasions during the study. Also, problems with the NO_x zero were encountered by BNW in the New York area. This occasionally resulted in slightly negative NO/NO_x values at a few points on vertical spirals. In addition, apparent imprecision in the humidity instrument operated by BNW resulted in the dew-point temperature slightly exceeding the ambient air temperature when high humidity was encountered.

7.2.4 Data Reduction

The continuous measurements recorded on magnetic tape from the on board analyzers were reduced from raw voltages into scientific units, using the calibration equations and zero/span data, according to procedures described in the reports prepared by each aircraft operator.[21,22,23,24,25] Quality Control checks conducted by the aircraft operators were accomplished by visually screening time versus concentration plots of the reduced data or the original strip chart trace as recorded in flight. Unusual fluctuations in air quality or meteorological parameters were checked for physical consistency. The data were also checked against flight logs to note any

instrument problems, zero checks, times when the aircraft passed through plumes, and the height of inversion layers. Data determined to be invalid were deleted from the data base. In addition, the aircraft data will be subject to more intensive screening prior to the creation of the modeling data base in 1983.

7.3 QA - Upper Air Meteorological Measurements

The instrument systems used by Beukers Laboratories for tracking and recording data from the radiosondes were calibrated prior to the start of the field program, as were the acoustic radar units deployed by AeroVironment. These systems have been found to be fairly stable during routine field operations and require recalibrations only after major repair. All of the radiosondes used during the study were purchased from VIZ and subject to QC by the manufacturer.

Most of the QA activities in the program were conducted during the data compilation and reduction phase. Quality Control checks of the upper air sounding data consisted of (1) a point-by-point review of each sounding in the field; (2) a check of each sounding while the data were being processed on the computer; and (3) a review of the temperature and wind sounding data for meteorological reasonableness and spatial and temporal continuity. Any soundings or individual data points which appeared suspect of being invalid were reprocessed, verified, and corrected or deleted, as appropriate.

The QC procedures for the sodar-derived mixing height data began in the field, when the measured values were reduced from the strip chart records. This enabled the technician to spot any readings indicative of possible instrument malfunctions. The strip charts were reevaluated and reviewed by AeroVironment at their Pasadena, CA facility, prior to being entered onto magnetic tape. In addition 10% of the values were spot checked by supervisory personnel.

No rigorous QC procedures have as yet been applied to the pilot balloon wind observations. However, the data were spot checked against the original data records, and all winds were reviewed for meteorological reasonableness and consistency, both between successive pibal observations and against rawinsonde wind data. No suspect data were identified.

In addition to the above QC checks, the upper air data will be further screened prior to the creation of the modeling data base in 1983.

7.4 QA - Hydrocarbon Species Measurement Program

Quality Assurance procedures during the collection and analysis of hydrocarbon species measurements included:

(1) analysis of all samples within 48 hours of collection;

(2) checking chromatograms for evidence of container contamination of samples;

(3) calibration of chromatographic columns with known standards;

(4) precision checks with artificial hydrocarbon mixtures; and

(5) a "round robin" analysis of specific samples by each laboratory.

A report describing the results of the "round robin" analyses is being prepared by the EPA Environmental Sciences Research Laboratory (ESRL). In addition, ESRL will be screening the species data to identify possible invalid data prior to the creation of the modeling data base in 1983.

8.0 Availability of NECRMP Urban Corridor Data Base

The data described in the preceding sections have been assembled into a data base available on magnetic tape. The surface air quality and meteorological data are recorded in SAROAD hourly data card image format. These data have been converted to a standard set of reporting units for each pollutant and meteorological parameter and to local standard time (LST). The special NECRMP rawinsonde and pilot balloon wind speed and direction data have been merged into a single data set. The rawinsonde temperature sounding data comprise another separate data set. The mixing height data obtained with the monostatic acoustic radar (sodar) were also place in SAROAD hourly data card image format. Since these mixing heights represent 30 minute values, there are four, rather than two, cards for each day. The aircraft data obtained in Washington, DC, New York, and Boston complete the Urban Corridor data base. A description of the NECRMP Urban Corridor data base, including data formats, reporting units, and tape specifications is contained in the report entitled: "Northeast Corridor Regional Modeling Project - Urban Corridor Data Base Description."[28] The entire NECRMP data base, including Urban Corridor data, Baltimore aircraft data, and other data sets obtained as part of the NEROS will be available from ESRL in 1983.

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APPENDIX A

AIR QUALITY / METEOROLOGICAL MONITORING SITES

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	SAROAD ID	SITE LOCATION	COUNTY	LATITUDE	LONGITUDE	PROBE HEIGHT (M) AGL	PROBE HEIGHT (M) MSL		SURFACE MEASUREMENTS AIR QUALITY		SURFACE MEASUREMENTS METEOROLOGICAL	
	CONNECTICUT											
1	070175123F01	DANBURY	FAIRFIELD CO	41 24 08	73 26 39	5	120	03			WS-WD	T
2	070199123F01	DERBY	NEW HAVEN CO	41 18 59	73 05 16	5	14	03			WS-WD	T
3	070330004F01	GREENWICH	FAIRFIELD CO	41 04 46	73 42 19	12	137	03		NO-NOX	WS-WD	T
4	070570007F01	MIDDLETOWN	MIDDLESEX CO	41 33 06	72 37 53	18	58	03		NO-NOX	WS-WD	T
5	071060001F01	STAFFORD	TOLLAND CO	41 58 33	72 23 12	14	270	03			WS-WD	T
6	071110007F01	STRATFORD POINT	FAIRFIELD CO	41 09 07	73 6 13	10	3	03			WS-WD	T
	DELAWARE											
7	080160070F05*	SUMMIT	NEW CASTLE CO	39 32 00	75 44 00	1	5	03				
8	080240001A05	MILLSBORO	SUSSEX CO	38 35 03	75 16 25	1	5	03				
	WASHINGTON DC					6	6	03				
9	090020017I01*	W.END LIBRARY	WASHINGTON	38 54 13	77 3 6	10	20	03	NMOC	NO-NOX		
10	090020025I01	TACOMA PARK	WASHINGTON	38 58 31	77 1 22	10	20	03	NMOC	NO-NOX		
	MARYLAND					10	91	03		NO2		
11	210050014G01	DAVIDSONVILLE	ANNE ARUNDEL CO	38 54 10	76 39 10	4	44	03			WS-WD	
12	210080019G05*	FT. MEADE	ANNE ARUNDEL CO	39 05 05	76 43 40	5	48	03	NMOC	NO-NOX	WS-WD	T-SR
13	210120004A05	E. READ ST.	BALTIMORE CITY	39 17 59	76 36 47	3	34	03	NMOC	NO-NOX		T-SR
14	210120016F01*	CALVERT & 22ND ST	BALTIMORE CITY	39 19 53	76 36 51	5	144	03	NMOC	NO-NOX		T-SR
15	210140010G01	GUNPOWDER/PERRY H	BALTIMORE CO	39 26 00	76 27 00	4	104	03		NO2	WS-WD	T-SR
16	210420030J05	RISING SUN	CECIL CO	39 43 07	76 6 22	6	13	03		NO-NOX		
17	210500007001	COCKEYSVILLE	BALTIMORE CO	39 27 40	76 37 52	4	186	03			WS-WD	
18	210565001F01	DAMASCUS	TALBOT CO	39 16 29	77 13 17	4	226	03		NO-NOX	WS-WD	
19	210650001F01	EDGEWOOD	HARFORD CO	39 26 00	76 17 50	4	6	03	NMOC	NO-NOX	WS-WD	
20	210680001G01*	ESSEX	BALTIMORE CO	39 18 38	76 28 29	5	10	03	NMOC	NO-NOX	WS-WD	
21	210740034001	LIBERTYTOWN	FREDERICK CO	39 23 47	77 13 55	5	152	03		NO-NOX	WS-WD	
22	210940002F01	GREENBELT	PRINCE GEORGES C	39 01 12	76 51 30	3	49	03		NO-NOX	WS-WD	T-SR
23	210920003J05	BEL AIR	HARFORD CO	39 34 34	76 19 46	7	10	03		NO-NOX	WS-WD	T-SR
24	210960005001	COLUMBIA	HOWARD CO	39 10 10	76 53 55	3	122	03		NO-NOX	WS-WD	
25	211380001F01	ROCKVILLE	MONTGOMERY CO	39 05 00	77 6 26	4	127	03		NO-NOX	WS-WD	
26	211560001F01	SUITLAND-SILVER H	PRINCE GEORGES C	38 51 12	76 55 55	5	12	03			WS-WD	
	MASSACHUSETTS											
27	220240021F01*	EAST BOSTON	METROPOLITAN BOS	42 22 41	71 1 42	4	6	03	NMOC	NO-NOX	WS-WD	
28	220430002F01	DANVERS	METROPOLITAN BOS	42 32 41	71 1 42	4	6	03	NMOC	NO-NOX	WS-WD	T
29	220535001F01*	EASTON	SOUTHEASTERN MAS	42 04 02	70 58 37	12	37	03	NMOC	NO-NOX	WS-WD	T
30	220730001F01	GEORGETOWN	MERRIMACK VALLEY	42 43 25	71 5 26	4	46	03	NMOC	NO-NOX	WS-WD	T-SR
31	220795001F01	HAMILTON	METROPOLITAN BOS	42 37 50	70 59 16	4	30	03	NMOC	NO-NOX	WS-WD	T-SR
32	221210001F01*	MEDFIELD	METROPOLITAN BOS	42 12 44	70 48 55	5	56	03	NMOC	NO-NOX	WS-WD	T
33	221392001A05	MONTAGUE	PIONEER VALLEY A	42 34 01	71 20 8	23	84	03	NMOC	NO-NOX	WS-WD	
34	222100003F01	SOMERVILLE	METROPOLITAN BOS	42 24 13	72 31 42	4	100	03		NO-NOX	WS-WD	T
35	222196001F01	SUDBURY	METROPOLITAN BOS	42 23 05	71 6 30	4	11	03		NO-NOX	WS-WD	T
36	222252001F01	TEWKSBURY	MERRIMACK VALLEY	42 36 29	71 23 20	4	40	03		NO-NOX	WS-WD	T
37	222380005F01*	WATERTOWN	METROPOLITAN BOS	42 22 29	71 13 14	4	46	03	NMOC	NO-NOX	WS-WD	T-SR
					71 10 57	4	19	03	NMOC	NO-NOX	WS-WD	T-SR

* NMOC data have an A05 agency code

	SAROAD ID	SITE LOCATION	COUNTY	LATITUDE	LONGITUDE	PROBE HEIGHT (M) AGL	PROBE HEIGHT (M) MSL	SURFACE MEASUREMENTS AIR QUALITY			SURFACE MEASUREMENTS METEOROLOGICAL	
MAINE												
38	300540009F01	PORTSMOUTH	ROCKINGHAM CO	43 04 41	70 45 46	3	4	03			WS-WD	
NEW JERSEY												
39	310180003F01*	BAYONNE	HUDSON CO	40 40 52	74 7 11	5	2	03	NMOC	NO-NOX		
40	311120001F01	DUMONT	BERGEN CO	40 56 16	73 59 42	5	26	03		NO-NOX		
41	311160003F01	EAST ORANGE	ESSEX CO	40 45 23	74 13 00	4	49	03		NO-NOX		
42	311500001F01	FLEMINGTON	HUNTERDON CO	40 31 00	74 48 36	4	40	03		NO-NOX	WS-WD	T-SR
43	312580002J05*	LINDEN	UNION CO	40 36 15	74 15 12	5	6	03	NMOC	NO-NOX		
44	313180004J05	MARLBORO	MONMOUTH CO	40 19 40	74 16 0	5	46	03		NO-NOX	WS-WD	T-SR
45	313260001F01	CHESTER	MORRIS CO	40 47 16	74 40 39	4	274	03			WS-WD	T
46	313480004A05	NEWARK NJIT	ESSEX CO	40 44 35	74 10 52	21	27		NMOC			
47	313480008F01	NEWARK	ESSEX CO	40 43 53	74 10 41	4	9	03		NO-NOX		
48	313500002F01*	NEW BRUNSWICK	MIDDLESEX CO	40 28 56	74 26 27	4	26	03	NMOC	NO-NOX	WS-WD	T
49	314300001F01	PLAINFIELD	SOMERSET CO	40 36 04	74 26 31	4	18	03		NO-NOX		
NEW YORK												
50	332900005F01	EISENHOWER PARK	NASSAU CO	40 44 43	73 35 13	5	24	03		NO-NOX	WS-WD	SR
51	332900010J05	GLEN COVE	NASSAU CO	40 53 30	73 35 55	5	30	03		NO-NOX	WS-WD	
52	334680004F01	QUEENS COLLEGE	QUEENS CO	40 44 13	73 49 9	29	44	03		NO-NOX		
53	334680007F01	SHEEPSHEAD BAY	KINGS CO	40 35 11	73 56 15	12	14	03			WS-WD	
54	334680010F01	MANHATTAN	NEW YORK CO	40 44 22	73 59 10	23	38	03		NO-NOX		
55	334680067F01	STATEN ISLAND	RICHMOND CO	40 35 50	74 7 27	18	104	03		NO-NOX	WS-WD	
56	334680070F01	ASTORIA QUEENS	QUEENS CO	40 46 39	73 54 18	6	8	03		NO-NOX		
57	334680076F01	BRKLYN-PS 321	KINGS CO	40 40 19	73 58 40	12	27	03		NO-NOX		
58	334680084A05	QUEENS-STEINWAY	QUEENS CO	40 45 28	73 55 2	3	18		NMOC			
59	334680085A05	BRKLYN-PROSPECT	NEW YORK CO	40 39 56	73 58 28	3	49		NMOC			
60	336520001J05	STONY BROOK	SUFFOLK CO	40 54 45	73 7 45	5	46	03			WS-WD	
61	337480004F01	WHITE PLAINS	WESTCHESTER CO	41 03 08	73 45 51	8	59	03		NO-NOX	WS-WD	
PENNSYLVANIA												
62	398040100A05	SCRANTON	LACKAWANNA CO	41 35 30	75 45 00	7	293	03				
VIRGINIA												
63	480200020G01*	AURORA HILLS	ARLINGTON CO	38 51 27	77 07 30	7	171	03	NMOC	NO2		
64	482520006F05*	CAMP UPSHUR	PRINCE WILLIAM C	38 38 31	77 31 42	5	56	03	NMOC	NO-NOX	WS-WD	
WEST VIRGINIA												
65	500580002A05	WHITE SULFUR SPRG	GREENBRIER CO	37 46 27	80 20 0	4	96	03				

* NMOC data have an A05 agency code

APPENDIX B

SPECIAL MEASUREMENT DATES

Washington, DC

	Date	Aircraft	Pibals	Rawinsondes		Sodar	Species			
	July			W	T		A	Y	K	U
M	14	-	x	-	-	-	-	x	x	-
T	15	x	x	-	-	-	x	x	x	-
W	16	x	x	-	-	-	x	x	x	-
T	17	-	x	-	-	-	-	x	x	-
F	18	-	x	-	-	x	-	x	x	-
S	19	x	x	-	-	x	x	-	-	-
S	20	-	x	-	-	x	-	-	-	-
	21	x	x	-	-	x	x	x	x	-
	22	x	x	-	-	x	x	x	x	-
	23	-	x	-	-	x	-	x	x	-
	24	-	x	-	x	-	-	x	x	-
	25	x	x	x	x	-	x	x	x	-
	26	-	x	-	-	x	-	-	-	-
	27	-	x	-	-	x	-	-	-	-
	28	-	x	x	x	x	-	x	-	x
	29	-	x	-	-	x	-	x	-	x
	30	-	x	-	-	x	-	x	-	x
	31	x	x	x	x	x	x	x	-	x

Washington, D.C.

Date August	Aircraft	Pibals	Rawinsondes W	Rawinsondes T	Sodar	Species A	Species Y	Species K	Species U
1	x	x	x	x	x	x	x	-	x
2	x	x	x	x	x	x	-	-	-
3	-	x	-	-	x	-	-	-	-
4	-	x	x	x	x	-	x	-	x
5	-	x	x	x	x	-	x	-	-
6	-	x	x	x	x	-	x	-	x
7	x	x	x	x	x	x	x	-	x
8	x	x	x	x	x	x	x	-	x
9	x	x	x	x	x	x	-	-	-
10	-	x	-	-	x	-	-	-	-
11	-	x	-	-	x	-	x	-	x
12	-	x	x	x	x	-	x	-	x
13	x	x	x	x	x	x	x	-	x
14	-	x	x	x	x	-	x	-	x
15	-	x	x	x	x	-	x	-	x
16	-	-	-	-	x	-	-	-	-
17	-	-	-	-	x	-	-	-	-
18	-	-	x	x	x	-	x	-	x
19	-	-	x	x	x	-	x	-	x
20	-	-	x	x	x	-	x	-	x
21	-	-	x	x	x	-	x	-	x
22	-	-	x	x	x	-	x	-	x
23	-	-	-	-	x	-	-	-	-
24	-	-	-	-	x	-	-	-	-
25	-	-	x	x	x	-	x	-	x
26	-	-	x	x	x	-	x	-	x
27	-	-	x	x	x	-	x	-	x
28	-	-	x	x	x	-	-	-	x
29	-	-	x	x	x	-	x	-	x
30	-	-	-	-	x	-	-	-	-
31	-	-	-	-	x	-	-	-	-

Washington, DC

Date	Aircraft	Pibals	Rawinsondes		Sodar	Species			
			W	T		A	Y	K	U
September									
1	-	-	x	x	x	-	-	-	-
2	-	-	-	-	x	-	-	-	-
3	-	-	x	x	x	-	-	-	-
4	-	-	x	x	x	-	-	-	-
5	-	-	x	x	x	-	-	-	-
6	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-
8	-	-	x	x	-	-	-	-	-
9	-	-	x	x	-	-	-	-	-
10	-	-	x	x	-	-	-	-	-
11	-	-	x	x	-	-	-	-	-
12	-	-	x	x	-	-	-	-	-

W: Winds
T: Temperature

A: Aircraft
Y: West End Library
K: Takoma Park
U: Univeristy of Maryland

Baltimore

	Date July	Aircraft S	Aircraft B	Pibal	Rawinsondes W	Rawinsondes T	Sodar	Species A	Species R	Species E
M	14	-	-	x	-	-	-	-	x	x
T	15	x	x	x	-	-	-	x	x	x
W	16	x	x	x	x	x	-	x	x	x
T	17	-	-	x	x	x	-	-	x	x
F	18	x	x	x	x	x	-	x	x	x
S	19	x	x	x	-	x	x	x	x	x
S	20	-	-	x	x	x	x	x	x	x
	21	x	x	x	-	-	x	-	x	x
	22	-	-	x	-	-	x	x	x	x
	23	-	-	x	-	-	-	-	-	x
	24	x	x	x	-	-	-	-	x	x
	25	x	x	x	x	x	-	x	x	x
	26	x	x	x	-	-	-	x	-	x
	27	x	x	x	-	-	-	x	x	x
	28	-	-	x	-	-	-	-	x	x
	29	-	-	x	x	x	-	x	x	x
	30	-	-	x	-	-	x	-	x	x
	31	x	x	x	-	-	x	-	x	x

Date	Aircraft		Baltimore				Species		
	S	B	Pibal	Rawinsondes W	Rawinsondes T	Sodar	A	R	E
August									
1	x	-	x	x	x	x	x	x	x
2	x	x	x	x	x	x	x	x	x
3	x	x	x	-	-	x	x	x	x
4	x	x	x	x	x	x	-	x	x
5	x	x	x	x	x	x	x	x	x
6	x	x	x	x	x	x	x	x	x
7	x	x	x	x	x	x	x	x	x
8	-	-	x	x	x	x	x	x	x
9	-	-	x	x	x	x	x	x	x
10	-	-	x	x	x	x	-	x	x
11	-	-	x	-	-	x	-	-	-
12	x	x	x	-	-	x	x	x	x
13	x	x	x	x	x	x	x	x	x
14	x	x	x	x	x	x	x	x	x
15	-	-	x	x	x	x	x	x	x
16	-	-	-	-	-	x	-	x	x
17	-	-	-	-	-	x	-	x	x
18	-	-	-	x	x	x	-	-	-
19	-	-	-	x	x	x	-	x	x
20	-	-	-	x	x	x	-	x	x
21	-	-	-	x	x	x	-	x	x
22	-	-	-	x	x	x	-	x	x
23	-	-	-	-	-	x	-	x	x
24	-	-	-	-	-	x	-	x	x
25	-	-	-	x	x	x	-	x	x
26	-	-	-	x	x	x	-	x	x
27	-	-	-	x	x	x	-	x	x
28	-	-	-	x	x	x	-	x	x
29	-	-	-	x	x	x	-	x	x
30	-	-	-	-	-	x	-	-	-
31	-	-	-	-	-	x	-	-	-

Baltimore

Date	Aircraft		Pibal	Rawinsondes		Sodar	Species		
	S	B					A	R	E
September									
1	-	-	-	x	x	x	-	-	-
2	-	-	-	x	x	x			
3	-	-	-	x	x	x	-	-	-
4	-	-	-	x	x	x	-	-	-
5	-	-	-	x	x	x	-	-	-
6	-	-	-	-	-	x	-	-	-
7	-	-	-	-	-	x	-	-	-
8	-	-	-	x	x	x	-	-	-
9	-	-	-	x	x	x	-	-	-
10	-	-	-	x	x	x	-	-	-
11	-	-	-	x	x	x	-	-	-
12	-	-	-	x	x	x	-	-	-
13	-	-	-	-	-	x	-	-	-

S: Washington State University
B: Brookhaven National Laboratory

W: Winds
T: Temperature

A: Aircraft
R: Read St.
E: Essex

New York City

	Date	Aircraft	Pibals		Rawinsondes						Sodar	Species		
			G	O	W			T				A	L	N
	July				D	N	M	D	N	M				
M	14	-	x	x	-	-	-	-	-	-	-	-	-	-
T	15	-	x	x	-	-	-	-	-	-	-	-	-	-
W	16	x	x	x	x	-	x	x	-	-	-	x	x	x
T	17	-	x	x	x	-	x	x	-	-	-	-	x	x
F	18	x	x	x	x	x	x	x	x	x	-	x	x	x
S	19	-	x	x	x	x	x	x	x	x	-	x	x	x
S	20	-	-	-	x	x	x	x	x	x	x	x	x	x
	21	x	x	x	x	x	x	x	x	x	x	-	x	x
	22	x	x	x	x	x	x	x	x	x	x	x	x	x
	23	-	x	x	-	-	-	-	-	-	x	x	x	x
	24	x	x	x	-	x	x	-	x	x	x	-	x	x
	25	x	x	x	x	x	x	x	x	x	x	x	x	x
	26	x	-	-	-	-	-	-	-	-	x	x	x	x
	27	x	-	-	-	-	-	-	-	-	x	-	x	x
	28	x	x	x	x	x	x	x	x	x	x	-	-	-
	29	-	x	x	-	-	-	-	-	-	-	x	x	x
	30	-	x	x	-	-	-	-	-	-	-	-	x	x
	31	x	x	x	x	x	x	x	x	x	x	-	x	x

New York City

Date August	Aircraft	Pibals G	Pibals O	Rawinsondes W D	Rawinsondes W N	Rawinsondes W M	Rawinsondes T D	Rawinsondes T N	Rawinsondes T M	Sodar	Species A	Species L	Species N
1	x	x	x	x	x	x	x	x	x	x	-	x	x
2	x	x	x	x	x	x	x	x	x	x	x	x	x
3	-	-	-	-	-	-	-	-	-	x	-	-	-
4	x	x	x	x	x	x	x	x	x	x	x	x	x
5	x	x	x	x	x	x	x	x	x	x	x	x	x
6	x	x	x	x	x	x	x	x	x	x	x	x	x
7	x	x	x	x	x	x	x	x	x	x	x	x	x
8	x	x	x	x	x	x	x	x	x	x	x	x	x
9	-	-	-	x	x	x	x	x	x	x	x	x	x
10	-	-	-	x	x	x	x	x	x	x	-	x	x
11	x	x	x	-	-	-	-	-	-	x	-	-	-
12	-	x	-	x	x	x	x	x	x	x	-	x	x
13	-	-	-	x	x	x	x	x	x	x	-	x	x
14	-	-	-	x	x	x	x	x	x	x	-	x	x
15	-	-	-	x	x	x	x	x	x	x	-	-	-
16	-	-	-	x	x	x	x	x	x	x	-	-	-
17	-	-	-	-	-	-	-	-	-	x	-	-	-
18	-	-	-	x	x	x	x	x	x	x	-	x	x
19	-	-	-	x	x	x	x	x	x	x	-	x	x
20	-	-	-	x	x	x	x	x	x	x	-	x	x
21	-	-	-	x	x	x	x	x	x	x	-	x	x
22	-	-	-	x	x	x	x	x	x	x	-	x	x
23	-	-	-	-	-	-	-	-	-	x	-	-	x
24	-	-	-	-	-	-	-	-	-	x	-	-	-
25	-	-	-	x	x	x	x	x	x	x	-	x	x
26	-	-	-	x	x	x	x	x	x	x	-	x	x
27	-	-	-	x	x	x	x	x	x	x	-	x	x
28	-	-	-	x	x	x	x	x	x	x	-	x	x
29	-	-	-	x	x	x	x	x	x	x	-	x	x
30	-	-	-	-	-	-	-	-	-	x	-	-	-
31	-	-	-	-	-	-	-	-	-	x	-	-	-

New York City

Date	Aircraft	Pibals		Rawinsondes						Sodar	Species		
				W			T						
September		G	O	D	N	M	D	N	M		A	L	N
1	-	-	-	x	x	x	x	x	x	x			
2	-	-	-	x	x	x	x	x	-	x	-	-	-
3	-	-	-	x	x	x	x	x	-	x	-	-	-
4	-	-	-	-	x	x	-	x	-	x	-	-	-
5	-	-	-	-	x	x	-	x	-	x	-	-	-
6	-	-	-	-	-	-	-	-	-	x	-	-	-
7	-	-	-	x	-	-	-	-	-	x	-	-	-
8	-	-	-	-	x	x	-	x	-	x	-	-	-
9	-	-	-	-	x	x	-	x	-	x	-	-	-
10	-	-	-	-	x	x	-	x	x	x	-	-	-
11	-	-	-	-	x	x	-	x	x	x	-	-	-
12	-	-	-	x	x	x	x	x	-	x	-	-	-
13	-	-	-	-	-	-	-	-	-	x	-	-	-

W: Winds
T: Temperature

G: Glen Cove
O: Morristown
D: Derby
N: Newark
M: Marlboro

A: Aircraft
L: Linden
N: Newark

Boston

	Date	Aircraft	Pibals		Rawinsondes		Sodar	Species		
	July		B	M	W	T		A	E	R
M	14	x	x	x	-	-	-	x	x	x
T	15	x	x	x	-	-	-	x	x	x
W	16	x	x	x	-	-	-	x	x	x
T	17	x	x	x	-	-	-	x	x	x
F	18	-	-	-	x	x	-	-	x	x
S	19	x	x	x	x	x	-	x	x	x
S	20	-	-	-	x	x	-	x	x	x
	21	-	x	x	x	x	-	-	x	x
	22	-	x	x	x	-	x	-	-	-
	23	-	-	-	-	-	x	-	-	-
	24	x	x	x	x	x	x	-	x	x
	25	x	x	x	x	x	x	x	x	x
	26	-	-	-	-	-	x	x	x	x
	27	-	-	-	-	-	x	-	x	x
	28	x	x	x	x	x	x	-	x	x
	29	-	-	-	-	-	x	-	-	-
	30	-	-	-	-	-	x	-	-	x
	31	x	x	x	x	x	-	-	x	x
	August									
	1	x	x	x	x	x	-	x	x	x
	2	-	x	x	x	x	-	-	x	x
	3	-	-	-	-	-	-	-	x	x
	4	-	-	-	x	x	-	-	x	x
	5	x	x	x	x	x	-	x	x	x
	6	x	x	x	x	x	-	x	x	x
	7	-	x	x	x	x	-	-	x	x
	8	x	x	x	x	x	-	-	x	x
	9	x	x	x	x	x	x	x	x	x
	10	-	-	-	-	-	x	x	x	x
							x	-	x	x

Boston

Date	Aircraft	Pibals		Rawinsondes		Sodar	Species		
August		B	M	W	T		A	E	R
11	-	-	-	-	-	x	-	x	x
12	-	-	-	x	x	x	-	x	x
13	-	-	-	x	x	x	-	x	x
14	x	-	-	x	x	x	-	x	x
15	-	-	-	x	x	-	-	x	x
16	-	-	-	-	-	-	-	x	x
17	-	-	-	-	-	x	-	x	x
18	-	-	-	x	x	x	-	x	x
19	-	-	-	x	x	x	-	x	x
20	-	-	-	x	x	x	-	x	x
21	-	-	-	x	x	x	-	x	x
22	-	-	-	x	x	x	-	x	x
23	-	-	-	-	-	x	-	x	x
24	-	-	-	-	-	x	-	x	x
25	-	-	-	x	x	x	-	x	x
26	-	-	-	x	x	x	-	x	x
27	-	-	-	x	x	x	-	x	x
28	-	-	-	x	x	x	-	x	x
29	-	-	-	x	x	x	-	x	x
30	-	-	-	x	x	x	-	-	-
31	-	-	-	x	x	x	-	-	-
September									
1	-	-	-	x	x	x	-	-	-
2	-	-	-	x	x	x	-	-	-
3	-	-	-	x	x	x	-	-	-
4	-	-	-	x	x	x	-	-	-
5	-	-	-	x	x	x	-	-	-
6	-	-	-	-	-	x	-	-	-
7	-	-	-	-	-	x	-	-	-
8	-	-	-	x	x	x	-	-	-
9	-	-	-	-	-	x	-	-	-
10	-	-	-	x	x	x	-	-	-

Date September	Aircraft	Pibals		Rawinsondes		Sodar	Species		
		B	M	W	T		A	E	R
11	-	-	-	x	x	x	-	-	-
12	-	-	-	x	x	x	-	-	-
13	-	-	-	-	-	x	-	-	-
14	-	-	-	-	-	x	-	-	-
15	-	-	-	-	-	x	-	-	-
16	-	-	-	-	-	x	-	-	-

W: Winds
T: Temperature
A: Aircraft

B: Beverly Airport
M: Medfield
E: East Boston
R: Watertown

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16. ABSTRACT

This report describes the design and operation of the 1980 Urban Field Studies conducted as part of the Northeast Corridor Regional Modeling Project (NECRMP). The NECRMP is a multiphase program involving EPA and State/local agencies in the development of the Regional Oxidant Model and its application to the Northeastern United States. The 1980 Urban Field Studies were conducted to provide the data base of air quality and meteorological measurements necessary for modeling the major Corridor cities: Washington, Baltimore, New York and Boston. [A data base for modeling Philadelphia was acquired in 1979.] The 1980 field studies included continuous surface measurements of ozone, nitrogen oxides, hydrocarbons, wind speed, wind direction, temperature, and solar radiation in the vicinity of these cities. In addition, special measurements of hydrocarbon species, aircraft monitoring flights, sodars, pilot balloon observations, and rawinsonde soundings were employed to obtain air quality and meteorological measurements aloft in the Corridor. Quality assurance procedures conducted as part of the data collection/reduction tasks are also described in the report. Lists of the designated NECRMP monitoring sites and the dates/times of species sample collection and of measurements aloft are provided in the appendices.

17. KEY WORDS AND DOCUMENT ANALYSIS

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